Southwest Region
777 Sonoma Avenue, Room 325
Santa Rosa, California 95404

May 28, 2003

Ms. Kim Cotto
Department of Water Resources
1416 Ninth Street, Room 1115-16
PO Box 942836
Sacramento, California 94236-0001

Magalie Salas
Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

Dear Ms. Cotto and Ms. Salas:

This concerns the Department of Water Resources (DWR), February 23, 2003, Scoping Document 2, for the Oroville facilities relicensing (FERC N0. 2100). This letter provides the National Marine Fisheries Service (NOAA Fisheries) comments on Scoping Document 2. We appreciate the opportunity to participate in the Alternative Licensing Process (ALP) for the Oroville Project. We are, however, concerned with premature constraints placed on the level of analyses to be conducted as well as the current pace of relicensing.

For certain of the study plans DWR and its consultants are reluctant to collect empirical data; opting to conduct literature reviews in lieu of essential field work. In particular, we are concerned with the adequacy of the cumulative impact assessment. As you know, FERC cannot issue its License for this project (relicense) absent an adequate evaluation of potential project impacts. Under §§ 14 and 15 of the FPA, FERC must make the same inquiries in a relicensing proceeding as in an initial licensing determination and there is no question that fishery protection is among the licensing issues that must be addressed when evaluating all beneficial water uses as required by § 10(a) of the FPA.[1] [2] In conducting an environmental evaluation, the level of analysis should be

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[1] Confederated Tribes and Bands of the Yakima Indian Nation et al. V. FERC, Nos. 82-7561 et al. (9th Cir. June 7, 1984.

[2] Id. At 11-12 (citing16 U.S.C. § 803 (a) and Udall v. FPC, 387 U.S. 428, 440, 450 (1967)).

commensurate with the level of impacts. For some resource areas, the level and scope of impacts are fairly straightforward. However, for other impacts and resource areas, such as anadromous fish, the level of impact and degree of interaction with other resource areas can only be revealed through site specific study. Therefore, limiting the proposed level of analysis prior to conducting studies is premature and may lead to a deficient license application and/or additional information requests.

In previous correspondence, NOAA Fisheries provided guidance to DWR on satisfying the mandates of the Endangered Species Act (ESA), National Environmental Policy Act (NEPA), the Magnuson-Stevens Fishery Management and Conservation Act (EFH) and Federal Power Act (FPA). However, NOAA Fisheries does not believe that the process of analysis proposed by DWR in Scoping Document 2 will meet our minimum requirements for a Preliminary Draft Environmental Analysis or draft Biological Assessment. Accordingly, it appears that the Applicant prepared NEPA document for this relicensing will not enable FERC to satisfy its NEPA responsibilities.

To date, DWR has presented study plans for consideration by NOAA Fisheries and the collaborative intended to address direct impacts only, while omitting impacts that DWR deems indirect or cumulative. DWR's distinction between types of impacts and the separation of study plans appears arbitrary and inconsistent with FERC regulations. Regardless, DWR has confirmed that it would introduce a separate study plan addressing cumulative impacts (see Action Item #E39 from the September 26, 2001 Environmental Work Group Meeting,[3] as well as the "Draft Guidance" dated 6/21/02, page 3, Step 1). However, on May 14, 2003, after approval of the initial study plans (SP-F1 through SP-F21), DWR announced its intention <u>not</u> to produce a cumulative impacts study plan. This change has significant ramifications which hinder our ability to fulfill our trust resource obligations. During this relicensing process, at least 18 months have elapsed from the time at which a cumulative impacts study was assured until the present time. Our concern is that the Preliminary Draft Environmental Assessment will be inadequate, and there will be an insufficient amount of time to address our requirements.

NOAA Fisheries and the other ALP participants have participated in good faith in this collaborative relicensing process, however we believe that the process outlined by Scoping Document 2 and the Draft Guidance document is inadequate for developing an administrative record which satisfies the provisions of the ESA, NEPA, EFH and the FPA. Scoping Document 2 does not define the scope of the analysis, therefore, the intent of this document is not satisfied. Instead, it refers to a document in draft which does not provide timelines or phasing triggers for its proposed progressive analysis, which may have otherwise satisfied our requirements. In Section 6.0, Scoping Document 2 states "The Environmental

[3] Please see the Environmental Work Group meeting summary for 11-28-01, http://orovillerelicensing.water.ca.gov/pdf_docs/11-28-01enviro_sum.pdf

Working Group has developed a draft guidance document to assist DWR in conducting the cumulative impact analysis on ESA species", however this document has never been approved by the collaborative, and was previously rejected by NOAA Fisheries and several other participants.

Our letters dated October 11, 2001 and December 5, 2002 (attached) provide appropriate guidance to address impacts. However, Scoping Document 2 and the Draft Guidance dated June 21, 2002, fail to address the issues raised in these letters. Specifically, the Draft Guidance sets arbitrary limitations on the scope of the analysis, extending upstream to the next barrier to fish migration (at minimum a direct impact, but clearly not accounting for indirect or cumulative impacts) and downstream to the confluence with the Sacramento River (although water releases from the Project could double Sacramento River flow or significantly reduce flow, impacting Delta fisheries and their habitats, for example).

In many instances the DWR has been forthcoming in its efforts to provide information, and NOAA Fisheries can sympathize with restricted budgets and workload to some extent, however we are unable to authorize a reduction in the quality of the analysis. NOAA Fisheries wishes to make clear that it rejects the Draft Guidance. We therefore recommend that DWR follow the process below to complete the cumulative impacts analysis. The numbered steps refer to the process outlined DWR's Scoping Document 2:

- Create a task force which will oversee the progress of the analyses. This task force will not follow the Draft Guidance or take it up for revision.
- Submit to the Plenary Steps 1 through 5 of Scoping Document 2 (without further reference to the Draft Guidance document) on or before July 29, 2003. This could potentially allow NOAA Fisheries and the collaborative to correct possible inadequacies in the scope of the analysis, with sufficient time to progress through Steps 6 and 7. DWR has previously been provided with sufficient verbal and written information in order to satisfy Steps 1-4, however we encourage DWR to consult with the collaborative as a whole or individually, as long as it does not prevent the timely submission of the products of Steps 1-5.
- Begin Steps 6 and 7 on or before July 29, 2003 for each resource impact analysis proposed by DWR which has the approval (by consensus) of the Plenary Group. DWR should document all verbal and written comments received and present a written update of the progress of the PDEA document at each Plenary meeting, from August 2003 until presentation of the PDEA.

In order fully understand the impacts of this large project (which includes the tallest dam in the United States), NOAA Fisheries recommends that the following tasks be completed and incorporated in the NEPA document:

1) Analyses which determine the cumulative impacts of Federal and non-Federal actions upon the decline of Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*O. mykiss*), green sturgeon (*Acipenser medirostris*), Pacific lamprey (*Lampetra tridentata*), and other anadromous fish species currently present in the Feather River.

2) A survey of holding, spawning, and rearing habitat for Central Valley spring-run Chinook salmon and Central Valley steelhead in the Feather River above Oroville Dam, using the historical range of spring-run Chinook salmon provided by Yoshiyama et al.[4] as a preliminary guide. This analysis should assume that all man-made barriers would be made passable. In addition, an analysis which determines the historic (pre-development) migration barriers should be provided for Flea Valley, Grizzly, Wildcat, Chips, Yellow and Spanish Creeks. The aerial survey is to be conducted in a manner similar to that conducted on the Yuba River.[5,6]

3) Fish passage studies as described at the May 21, 2003 EWG meeting, whether considered direct, indirect, cumulative, or PM&E.

4) Determine the impacts of project operations on the resuspension and transport of elemental mercury and, based on these results, develop a plan to minimize re-suspension and transport of elemental mercury.

5) Determine the impacts of project operations on the methylization of mercury (reservoir fluctuation and pump storage) and develop a plan to minimize re-

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[4] Please refer to:
Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: Final report to Congress, vol.III. Centers for Water and Wildland Resources, Univ. Cal. Davis. pg. 309-361.
and
Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher and P.B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. in Contributions to the Biology of Central Valley Salmonids. Fish Bulletin 179. R.L. Brown ed.

[5] This data should be gathered according to the protocol described in the Upper Yuba River Studies Program, dated September 27, 2000, Upstream and Downstream Habitat Work Plan (SAC/003670442).

[6] The Feather River Project blocks access to all of this habitat in part, therefore the DWR is at least partially responsible for the cost of all of this study. In its Interagency Task Force agreements, FERC has stated that “For projects within the same watershed, FERC will consider cumulative effects at original licensing or relicensing to the fullest extent possible” and “Where relevant, the NEPA document will identify other watershed activities including hydropower projects and will analyze the effects of the proposed project and alternatives in combination with other projects and activities.” Relevance is here without question, as the Feather River Project has in the past been considered to block anadromous fish passage for the entire watershed above it, therefore DWR is in this way responsible for the entirety of this relatively inexpensive study. NOAA Fisheries holds DWR responsible for the production of this information in the same manner as it would a direct, indirect or cumulative impact to the watershed below its project.

suspension and transport of methylated mercury.

6) Conduct a detailed and comprehensive survey of reservoir sediments and determine areas of high concentrations of both elemental and methylated mercury and develop a feasibility plan to either remove (suction dredge) or cap (clay cap) mercury hot-spots.[7]

[7] DWR should consider off-site mitigations such as remediating abandoned Hg mines around the S.F. Bay in case mitigations are considered too expensive relative to benefit. Hg is impacting Essential Fisheries Habitat in the Bay and Delta.

Our concern is that DWR develop an adequate administrative record upon which to base our prescriptions and recommendations within statutory filing deadlines.[8] An incomplete license application may lead to additional information requests or other administrative delays. In turn, a lengthy delay in issuing a new license may result in irreparable harm to sensitive resources through the ongoing impacts of current project facilities and operations. As DWR's failure to conduct a comprehensive cumulative impacts analysis is likely to delay the relicensing process, it calls into question the effectiveness of the ALP to address these issues in a timely manner. NOAA Fisheries has provided sufficient guidance for DWR to conduct necessary studies and analyses without further delay. For further information regarding this letter, please contact Mr. Eric Theiss at 916-930-3613.

Sincerely,

/s Miles Croom

Miles M. Croom
Northern California Supervisor
Habitat Conservation Division

Enclosure

cc: Henry Ramirez - Oroville Facilities Relicensing Program
Michael Hoover - USFWS
Sharon Stohrer - CSWRCB
Harvey Angle - Tribal Unity Council
Richard Roos-Collins
Bob Hawkins - USFS
Mike Meinz - CDFG
Michael Aceituno - NOAA Fisheries
Howard Brown - NOAA Fisheries
Bruce Oppenheim - NOAA Fisheries
Eric Theiss - NOAA Fisheries

[8] 18CFR16.8

ATTACHMENT A

NOAA FISHERIES GOALS AND OBJECTIVES

(FERC No. 2100)

BACKGROUND

Historically, California produced the most biologically diverse and productive salmonid fisheries in North America. Its 60 major watersheds include over 20,000 miles of rivers and streams.[9] California's coastal river systems once had annual runs of adult steelhead numbering more than one million. However, water development has taken its toll on the salmon and steelhead resources of the state. Dams and diversions were constructed in all but a dozen of the state's major drainages. Today, dams greater than 25-feet in height number over 1,200.[10]

Hydropower, flood control, and water supply dams of the Central Valley Project, State Water Project, and other municipal and private entities permanently block or hinder salmonid access to historical spawning and rearing grounds. Clark (1929) estimated that originally there were 6,000 miles of salmon habitat in the Central Valley system and that 80 percent of this habitat was lost by 1928. Yoshiyama *et al*. (1996) calculated that roughly 2,000 miles of salmon habitat was actually available before dam construction and mining, and concluded that 82 percent is not accessible today. Clark (1929) did not give details of his calculation. Whether Clark's or Yoshiyama's calculation is used, only remnants of their former range remain accessible today in the Central Valley (California Department of Fish and Game, (CDFG) 1998).

In general, large dams on every major tributary to the Sacramento River, San Joaquin River, and Delta block salmon and steelhead access to the upper portions of respective watersheds. On the Sacramento River, Keswick Dam blocks passage to historic spawning and rearing habitat in the upper Sacramento, McCloud, and Pit Rivers. On the Feather River, Oroville Dam and associated facilities block passage to the upper Feather River watershed. Nimbus Dam blocks access to most of the American River Basin. On the San Joaquin River, water development projects in the 19th century eliminated fall-run Chinook salmon that spawned in the mainstem of the river. Friant Dam construction in mid-1940's eliminated most of Spring-Run Chinook salmon in the San Joaquin River upstream of the Merced River (DOI 1999a).

Hydropower development and related water management activities have drastically altered natural hydrologic conditions and aquatic habitat in the Feather River, resulting in substantial reductions in salmonid abundance. Aside from simply blocking access to historic habitat, hydropower development adversely affects fish populations in other ways: migration delay resulting from insufficient

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[9] Forest and Rangeland Resources Assessment Program. 1988. California's Forests and Rangelands: Growing Conflict Over Changing Uses. California Department of Forestry and Fire Protection. Sacramento, CA.

[10] California State Lands Commission. 1993. California's Rivers: A Public Trust Report. Sacramento, CA 334 pp.

flows or habitat blockages; stranding of fish caused by rapid flow fluctuations; significant habitat alteration which reduces the carrying capacity for salmonids and their forage species and increased mortality resulting from alterations in ambient water temperatures thus exacerbating water quality impacts (Palmisano 1993). In several listings of Pacific salmonids under the Federal Endangered Species Act, NOAA Fisheries identified impacts associated with hydropower development as factors in the decline of these species (62 FR. 43,937, 43,942).

NOAA FISHERIES INTEREST IN THIS PROCEEDING

The NOAA Fisheries is responsible for protecting and managing a variety of marine animals, including Pacific salmon, sturgeon, lamprey, groundfish, halibut, and marine mammals and their habitats under the Federal Endangered Species Act (ESA)(16 U.S.C. §§ 1531 *et seq.)*, Federal Power Act, Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act) (16 U.S.C. 1801 et seq.), Reorganization Plan Number 4 of 1970, and other laws. Specifically:

Essential Fish Habitat

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act set forth a number of new mandates for NOAA Fisheries, regional fishery management councils, and other Federal agencies to identify and protect important marine and anadromous fish habitat. The Councils, with assistance from NOAA Fisheries, are required to delineate “Essential Fish Habitat” (EFH) for all managed species. Federal action agencies that fund, permit, or carry out activities that may adversely impact EFH, are required to consult with NOAA Fisheries regarding the potential effects of their actions on EFH, and respond in writing to our recommendations. In addition, NOAA Fisheries is required to comment on any state agency activities that would impact EFH.

Endangered Species Act

The purpose of the ESA is to conserve endangered and threatened species and the ecosystems upon which they depend. To this end, the ESA provides for prohibitions on the “take” of endangered and threatened species. Section 7 of the ESA establishes a policy that all federal agencies will seek to conserve listed species by using their authorities to carry out conservation programs for such species. Furthermore, federal agencies must ensure that any action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any listed species. When listed salmon or steelhead may be affected by a federal action, the federal agency must consult with NOAA.

National Environmental Policy Act

The National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et seq.) is the foundation of modern American environmental protection in the United States and its commonwealths, territories, and possessions. The implementing regulations for NEPA require that Federal action agencies must analyze the direct and indirect environmental effects and cumulative impacts of project alternatives and connected actions.

Indirect Effects

Increased diversions associated with the construction of increased screening capacity is an “Indirect Effect” of the proposed action. The California Environmental Quality Act (CEQA) regulations under 40 CFR 1508.8 (b) defines indirect effects as those “which are caused by the action and are later in time or farther removed in distance, but are still reasonably foreseeable. Indirect effects may include human population growth inducing effects and other effects related to induced changes in the pattern of land use, population density or growth rate, and related effects on air and water and other natural systems, including ecosysytems”.

Cumulative Impacts

Cumulative impacts are those combined effects on quality of the human environment that result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions, regardless of what Federal or non-Federal agency or person undertakes such other actions (40 CFR 1508.7, 1508.25(a), and 1508.25(c)). Cumulative impacts can result from individually minor, but collectively significant actions taking place over a period of time.

Connected Actions

The CEQA regulations require “connected actions” to be considered together in a single Environmental Impact Statement (EIS). See 40 CFR §1508.25 (a)(1). “Connected Actions” are defined, as actions that: (i) automatically trigger other actions which may require environmental impact statements; (ii) cannot or will not proceed unless other actions are taken previously or simultaneously; (iii) are independent parts of a larger action and depend upon the larger action for their justification.”

The Licensee’s operation and maintenance of its Project and resulting land use practices meet the above criteria for “Indirect Effects” “Cumulative Impacts” and “Connected Actions”. For instance, the Licensee’s facilities and operations are inextricably intertwined concerning the impoundment, release from storage, conveyance, and use of the waters of the upper North Fork Feather River.

Federal Power Act (FPA)

<u>Section 18 of the FPA</u>

Section 18 of the FPA expressly grants to the Department of Commerce and the Department of the Interior (Departments) exclusive authority to prescribe fishways. Section 18 states that the Commission must require construction, maintenance, and operation by a licensee at its own expense of such fishways as may be prescribed by the Secretary of Commerce or the Secretary of the Interior. Fishways prescribed under Section 18 by the Departments are mandatory upon the Commission. Within the Department of the Interior, the authority to prescribe fishways is delegated from the Secretary of the Interior to the FWS Regional Directors. Within the Department of Commerce, the authority to prescribe fishways is delegated to the NOAA Fisheries Regional Administrators.

<u>Section 10(j) of the FPA</u>

Under Section 10(j) of the FPA, licenses for hydroelectric projects must include conditions to protect, mitigate damages to, and enhance fish and wildlife resources, including related spawning grounds and habitat. These conditions are to be based on recommendations received from federal and state fish and wildlife agencies. The Commission is required to include such recommendations unless it finds that they are inconsistent with Part I of the FPA or other applicable law, and that alternative conditions will adequately address fish and wildlife issues. Before rejecting an agency recommendation, the Commission and the agencies must attempt to resolve the inconsistency, giving due weight to the agencies’ recommendations, expertise, and statutory authority. If the Commission does not adopt a 10(j) recommendation, in whole or in part, it must publish findings that adoption of the recommendation is inconsistent with the purposes and requirements of Part 1 of the FPA or other applicable provisions of law, and that conditions selected by the Commission adequately and equitably protect, mitigate damages to, and enhance fish and wildlife, including related spawning grounds and habitat.

Section 10(a)(1) of the FPA

Resources agencies may also recommend conditions under section 10(a)(1) of the FPA. However, the Commission may accept, modify, or reject those conditions under the comprehensive development standard of Section 10(a)(1) without attempting to resolve inconsistencies or making the findings required by Section 10(j).

Authority to Recommend Studies During Relicensing

The Code of Federal Regulations (CFR) at 18 CFR 16.8(b)(4) direct interested resource agencies to provide a potential applicant with written comments. The NOAA Fisheries has identified studies that are necessary to assess the environmental and social consequences of the proposed relicensing. Under 18 CFR each interested resource agency and Indian tribe must provide a potential applicant with written comments:

i) identifying its determination of necessary studies to be performed or information to be provided by the potential applicant;

ii) identifying the basis for its determination;

iii) discussing its understanding of the resource issues and its goals and objectives of these resources;

iv) explaining why each study methodology recommended by it is more appropriate than other available methodology alternatives, including those identified by the potential applicant pursuant to paragraph (b) (1) (vi) of this section;

v) documenting that the use of each study methodology recommended is a generally accepted practice; and

vi) explaining how the studies and information requested will be useful to the agency or Indian tribe in furthering its resource goals and objectives.

SPECIES DESCRIPTION AND STATUS

Central Valley (CV) Spring-Run Chinook salmon (*O. tshawytscha*) are listed as threatened under the ESA (September 16, 1999, 64 FR 50394). This Evolutionarily Significant Unit (ESU) consists of Spring-Run Chinook salmon occurring in the Sacramento River Basin. Designated critical habitat for Central Valley Spring-Run Chinook salmon includes all river reaches accessible to listed Chinook salmon in the Sacramento River and its tributaries in California, except for reaches on Indian tribal lands. Also included are river reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. This critical habitat designation includes all waterways, substrate, and adjacent riparian zones. Excluded are: (1) areas above specific dams identified in the Federal Register notice; (2) areas above longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years); and (3) Indian tribal lands (February 16, 2000, 65 FR 7764).

The CV steelhead (*O. mykiss*) are listed as threatened under the ESA (March 19, 1998, 63 FR 13347). This ESU consists of steelhead populations in the Sacramento and San Joaquin River Basins in California's Central Valley. Designated critical habitat for CV steelhead includes all river reaches accessible to listed steelhead in the Sacramento and San Joaquin rivers and their tributaries in California, except for reaches on Indian tribal lands. Also included are river reaches and estuarine areas of the Sacramento-San Joaquin Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and Carquinez Strait, all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of the San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge. Excluded are: (1) areas above specific dams identified in the Federal Register notice; (2) areas above longstanding, natural impassable barriers (i.e., natural waterfalls in existence for at least several hundred years); (3) Indian tribal lands; and (4) areas of the San Joaquin River upstream of the Merced River confluence (February 16, 2000, 65 FR 7764).

Following are descriptions of the general life histories and population trends of listed species that may be directly or indirectly affected by the proposed action.

Chinook Salmon

General Life History

Chinook salmon historically ranged from the Ventura River in southern California north to Point Hope, Alaska, and in northeastern Asia from Hokkaido, Japan to the Anadyr River in Russia (Healey 1991).

Of the Pacific salmon, Chinook salmon exhibit arguably the most diverse and complex life history strategies. Healey (1986) described 16 age categories for Chinook salmon, 7 total ages with 3 possible freshwater ages. Two generalized freshwater life-history types were described by Healey (1991): "stream-type" Chinook salmon reside in freshwater for a year or more following emergence, whereas "ocean-type" Chinook salmon migrate to the ocean within their first year.

Chinook salmon mature between 2 and 6+ years of age (Myers *et al.* 1998). Freshwater entry and spawning timing are generally thought to be related to local water temperature and flow regimes (Miller and Brannon 1982). Runs are designated on the basis of adult migration timing; however, distinct runs also differ in the degree of maturation at the time of river entry, thermal regime and flow characteristics of their spawning site, and actual time of spawning (Myers *et al.* 1998). Spring-Run Chinook salmon tend to enter freshwater as immature fish, migrate far upriver, and finally spawn in the late summer and early autumn. Fall-Run Chinook salmon enter freshwater at an advanced stage of maturity, move rapidly to their spawning areas on the mainstem or lower tributaries of the rivers, and spawn within a few days or weeks of freshwater entry (Healey 1991).

Central Valley Spring-Run Chinook salmon adults are estimated to leave the ocean and enter the Sacramento River from March to July (Myers *et al*. 1998). Spring-Run Chinook spawning typically occurs between late-August and early October with a peak in September. Spawning typically occurs in gravel beds that are located at the tails of holding pools (U. S. Fish and Wildlife Service 1995). Eggs are deposited within the gravel where incubation, hatching, and subsequent emergence takes place. The upper preferred water temperature for spawning adult Chinook salmon is 55° F (Chambers 1956) to 57° F (Reiser and Bjornn 1979). Length of time required for eggs to develop and hatch is dependant on water temperature and is quite variable. In Butte and Big Chico creeks, emergence of Spring-Run Chinook typically occurs from November through January. In Mill and Deer creeks, colder water temperatures delay emergence to January through March (CDFG 1998).

Post-emergent fry seek out shallow, nearshore areas with slow current and good cover, and begin feeding on small terrestrial and aquatic insects and aquatic crustaceans. In Deer and Mill creeks, juvenile spring-run Chinook usually spend 9-10 months in their natal streams, although some may spend as long as 18 months in freshwater. Most “yearling” Spring-Run Chinook move downstream in the first high flows of the winter from November through January (USFWS 1995; CDFG 1998). In Butte and Big Chico creeks, Spring-Run Chinook juveniles typically exit their natal tributaries soon after emergence during December and January, while some remain throughout the summer and exit the following fall as yearlings. In the Sacramento River and other tributaries, juveniles may begin migrating downstream almost immediately following emergence from the gravel with emigration occurring from December through March (Moyle, *et al*. 1989; Vogel and Marine 1991). Fry and parr may spend time rearing within riverine and/or estuarine habitats including natal tributaries, the Sacramento River, non-natal tributaries to the Sacramento River, and the Delta.

Chinook salmon spend between one and four years in the ocean before returning to their natal streams to spawn (Myers *et al*. 1998). Fisher (1994) reported that 87 percent of returning spring-run adults are three-years-old based on observations of adult Chinook trapped and examined at Red Bluff Diversion Dam between 1985 and 1991.

Adult Sacramento River Winter-Run Chinook salmon leave the ocean and migrate through the Sacramento-San Joaquin Delta to the upper Sacramento River from December through June. Spawning generally occurs between mid-April and July, and occasionally into early August. The majority of Winter-Run Chinook salmon spawning occurs upstream of Red Bluff Diversion Dam in the vicinity of Redding, California. The eggs are fertilized and buried in the river gravel where they incubate and hatch in approximately a two-month period.

Emergence of the fry from the gravel begins during early July and continues through September. Fall and winter emigration behavior by juveniles varies with streamflow and hydrologic conditions. Most juveniles redistribute themselves to rear in the Sacramento River through the fall and winter months. Some Winter-Run Chinook salmon juveniles move downstream to rear in the lower Sacramento River and Delta during the late fall and winter. Smolting and ocean entry typically occurs between January and April.

Population Trends - Central Valley Spring-Run Chinook Salmon

Historically, Spring-Run Chinook salmon were predominant throughout the Central Valley, occupying the upper and middle reaches of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud, and Pit rivers, with smaller populations in most other tributaries with sufficient habitat for over-summering adults (Stone 1874; Rutter 1904; Clark 1929). The Central Valley drainage as a whole is estimated to have supported Spring-Run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River (Fry 1961). Following the completion of Friant Dam, the native population from the San Joaquin River and its tributaries was extirpated. Spring-Run Chinook salmon no longer exist in the American River due to the existence and operation of Folsom Dam.

Natural spawning populations of Central Valley Spring-Run Chinook salmon are currently restricted to accessible reaches in the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and Yuba River (CDFG 1998; USFWS, unpublished data). With the exception of Butte Creek and the Feather River, these populations are relatively small ranging from a few fish to several hundred. Butte Creek returns in 1998 and 1999 numbered approximately 20,000 and 3,600, respectively (CDFG unpublished data). On the Feather River, significant numbers of Spring-Run Chinook, as identified by run timing, return to the Feather River Hatchery. However, coded-wire-tag information from these hatchery returns indicates substantial introgression has occurred between Fall-Run and Spring-Run Chinook populations in the Feather River due to hatchery practices. Additional historical and recent published Chinook salmon abundance information are summarized in Myers *et al.* (1998).

Steelhead

General Life History

Steelhead exhibit perhaps the most complex suite of life history traits of any species of Pacific salmonid. They can be anadromous or freshwater resident. Resident forms are usually called rainbow trout. Winter steelhead generally leave the ocean from August through April, and spawning occurs between December and May (Busby *et al.* 1996). The timing of upstream migration is generally correlated with higher flow events and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al*. 1996; Nickelson *et al*. 1992). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al*. 1996).

Steelhead spawn in cool, clear streams featuring suitable gravel size, depth, and current velocity. Intermittent streams may be used for spawning (Barnhart 1986; Everest 1973).
The length of the incubation period for steelhead eggs is dependant on water temperature, dissolved oxygen concentration, and substrate composition. In late spring and following yolk sac absorption, alevins emerge from the gravel as fry and begin actively feeding in shallow water along perennial stream banks (Nickelson *et al*. 1992).

Summer rearing takes place primarily in higher velocity areas in pools, although young-of-the-year are also abundant in glides and riffles. Winter rearing occurs more uniformly at lower densities across a wide range of fast and slow habitat types. Productive steelhead habitat is characterized by complexity, primarily in the form of large and small wood. Some older juveniles move downstream to rear in larger tributaries and mainstem rivers (Nickelson *et al*. 1992). Juveniles feed on a wide variety of aquatic and terrestrial insects (Chapman and Bjornn 1969), and emerging fry are sometimes preyed upon by older juveniles. Juveniles live in freshwater from one to four years (usually two years in the California) (Barnhart 1986), then smolt and migrate to the sea from February through April. Although some steelhead smolts may outmigrant during the fall and early winter months.

California steelhead typically reside in marine waters for one to two years prior to returning to their natal stream to spawn as three- or four-year olds (Busby *et al.* 1996).

Population Trends - Central Valley Steelhead

Central Valley steelhead once ranged throughout most of the tributaries and headwaters of the Sacramento and San Joaquin basins prior to dam construction, water development, and watershed perturbations of the 19th and 20th centuries (McEwan and Jackson 1996; CALFED 2000). In the early 1960s, the California Fish and Wildlife Plan estimated a total run size of about 40,000 adults for the entire Central Valley including San Francisco Bay (CDFG 1965). The annual run size for this ESU in 1991-92 was probably less than 10,000 fish based on dam counts, hatchery returns and past spawning surveys (McEwan and Jackson 1996).

At present, all Central Valley steelhead are considered Winter-Run steelhead (McEwan and Jackson 1996), although there are indications that summer steelhead were present in the Sacramento River system prior to the commencement of large-scale dam construction in the 1940's (IEP Steelhead Project Work Team 1999). McEwan and Jackson (1996) reported wild steelhead stocks appear to be mostly confined to upper Sacramento River tributaries such as Antelope, Deer, and Mill creeks and the Yuba River. However, naturally spawning populations are also known to occur in Butte Creek, and the upper Sacramento mainstem, Feather, American, Mokelumne, Calaveras and Stanislaus rivers (CALFED 2000, McEwan 2001). It is possible that other naturally spawning populations exist in Central Valley streams, but are undetected due to lack of monitoring and research programs. The recent implementation of new fisheries monitoring efforts has found steelhead in streams previously thought not to contain a population, such as Auburn Ravine, Dry Creek, and the Stanislaus River (IEP Steelhead Project Work Team 1999).

Additional historical and recently published steelhead abundance are summarized in the
NOAA Fisheries west coast steelhead status review (Busby *et al.* 1996) and DFG assessment of current monitoring for Central Valley steelhead (McEwan, D. 2001).

Feather River steelhead are currently listed under the ESA, but anadromous runs are currently blocked at Oroville. At this time NOAA Fisheries has listed only the anadromous life form of *Oncorhynchus mykiss*. The Feather River Project (FERC No. 2100) at Oroville, the Upper North Fork Feather River Project (FERC No. 2105) and the Poe Project (FERC No. 2107) just upstream are currently in relicensing proceedings. Steelhead are native to the north Pacific Ocean and in North America are found in coastal streams from Alaska south to northwestern Mexico (Moyle 1976; Busby *et al*. 1996).

Life History and Biological Requirements

Steelhead spend from one to five years in saltwater, however, two to three years are most common (Busby *et al.* 1996). Some return as "half-pounders" that over-winter one season in freshwater before returning to the ocean in the spring. The distribution of steelhead in the ocean is not well known. Coded-wire tag recoveries indicate that most steelhead tend to migrate north and south along the continental shelf (Barnhart 1986).

The timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches, and associated lower water temperatures. The minimum stream depth necessary for successful upstream migration is 13 cm (Thompson 1972). The preferred water velocity for upstream migration is in the range of 40-90 cm/s, with a maximum velocity, beyond which upstream migration is not likely to occur, of 240 cm/s (Thompson 1972; Smith 1973). There are two types of steelhead, summer steelhead and winter steelhead. Summer steelhead return to freshwater during June through September, migrate inland toward spawning areas, overwinter in the larger rivers, and then resume migration to natal streams and spawn (Meehan and Bjornn 1991). Winter steelhead return to freshwater in autumn or winter, migrate to spawning areas, and then spawn in late winter or spring. Upstream migration of winter steelhead occurs from September through May with the peak run occurring in February (CDFG 1997). Most spawning takes place from January through April. Steelhead may spawn more than once before dying (iteroparity), in contrast to other species of the *Oncorhynchus* genus. Repeat spawning rates typically range from 13-24 percent in California coastal streams.

Because rearing juvenile steelhead reside in freshwater all year, adequate flow and temperature are important to the population at all times (CDFG 1997). Generally, throughout their range in California, steelhead that are successful in surviving to adulthood spend at least two years in freshwater before emigrating downstream. Emigration appears to be more closely associated with size than age. In Waddell Creek, Shapovalov and Taft (1954) found steelhead juveniles migrating downstream at all times of the year with the largest numbers of age 0+ and yearling steelhead moving downstream during spring and summer. Smolts can range from 14-21 cm in length.

Steelhead spawn in cool, clear streams featuring suitable water depth, gravel size, and current velocity. Intermittent streams may be used for spawning (Barnhart 1986; Everest 1973). Reiser and Bjornn (1979) found that gravels of 1.3-11.7 cm in diameter and flows of approximately 4-cfs were preferred by steelhead. The survival of embryos is reduced when fines of less than 6.4-mm comprise 20-25 percent of the substrate. Studies have shown a higher survival of embryos when intragravel velocities exceed 20-cm/hr (Phillips and Campbell 1961; Coble 1961). The number of days required for steelhead eggs to hatch is inversely proportional to water temperature and varies from about 19 days at 15.6^{o}C to about 80 days at 5.6^{o}C. Fry typically emerge from the gravel two to three weeks after hatching (Barnhart 1986).

Upon emerging from the gravel, fry rear in edgewater habitats and move gradually into pools and riffles as they grow larger. Older fry establish territories which they defend. Cover is extremely important in determining distribution and abundance, with more cover leading to more fish (Bjornn and Reiser 1991). Young steelhead feed on a wide variety of aquatic and terrestrial insects, and emerging fry are sometimes preyed upon by older juveniles. In winter, they become inactive and hide in any available cover, including gravel or woody debris.

Water temperature influences the growth rate, population density, swimming ability, ability to capture and metabolize food, and ability to withstand disease of these rearing juveniles

(Barnhart 1986; Bjornn and Reiser 1991). Rearing steelhead juveniles prefer water temperatures of 7.2-14.4^{o}C and have an upper lethal limit of 23.9^{o}C. They can survive up to 27°C with saturated dissolved oxygen conditions and a plentiful food supply. Fluctuating diurnal water temperatures also aid in survivability of salmonids (Busby *et al.* 1996).

Dissolved oxygen (DO) levels of 6.5-7.0-mg/l affected the migration and swimming performance of steelhead juveniles at all temperatures (Davis *et al.* 1963). Reiser and Bjornn (1979) recommended that DO concentrations remain at or near saturation levels with temporary reductions no lower than 5.0 mg/l for successful rearing of juvenile steelhead.
Low DO levels decrease the rate of metabolism, swimming speed, growth rate, food consumption rate, efficiency of food utilization, behavior, and ultimately the survival of the juveniles.

During rearing, suspended and deposited fine sediments can directly affect salmonids by abrading and clogging gills, and indirectly cause reduced feeding, avoidance reactions, destruction of food supplies, reduced egg and alevin survival, and changed rearing habitat (Reiser and Bjornn 1979). Bell (1973) found that silt loads of less than 25-mg/l permit good rearing conditions for juvenile salmonids.

Pacific Lamprey

Pacific lamprey (*Lampetra tridentata*) are found from Hokkaido Island (Japan) through Alaska, and down to Baja California, and have been observed in Deer Creek, approximately 440-km from the ocean (Moyle 2002). Lampreys are also called eels, and are an important cultural species to native Americans. The Eel River derives its name from a large run of lampreys. Lampreys are presumed to migrate upstream between February and June, although migrations in the Mokelumne river can occur outside of this window. Lampreys are an important component of riverine ecosystems, and along with salmon can bring scarce nutrients from the marine environment. Lampreys are at risk of extinction (Close et al 2002).

PROJECT IMPACTS ON ANADROMOUS FISHES

Salmonids require cool, clear, running water to support their freshwater life history stages (Bjornn and Reiser 1991). Incubating salmon eggs require clean gravel substrates. Juvenile habitats typically consist of free-flowing streams providing a complex of alternating shallow, swift riffles and low-velocity pools with abundant cover in the form of woody debris, boulders, and undercut banks. Dams convert natural stream habitats to artificial pond environments.

Habitats for salmonids are adversely affected by Project facilities because dams change stream flow patterns, reduce habitat diversity, diminish water quality, and create barriers to the natural instream movements of salmonids. Dams can also enhance the quality of habitats for species that are predators of juvenile salmon and steelhead.

In order to establish a complete administrative record, NOAA Fisheries requires a thorough evaluation of the feasibility of establishing anadromous salmonid populations in habitats above Oroville, the current most downstream barrier to anadromy. Using previously available technology, passage could certainly have been implemented, and the latest technology must be investigated to determine if this can be done more cost effectively. An appropriate balance must be determined for these resources, and to make this determination the agencies given this responsibility must be supplied with appropriate analyses. The protection, mitigation, and enhancement of listed and non-listed species may require that NOAA Fisheries implements up and downstream passage of these fish into the upper Feather River, as many of the naturally cool and productive tributaries of this watershed could be best utilized by re-introducing anadromous fish.

Fish passage is a basin-wide issue, and FERC has made it clear that it intends to study basin-wide issues comprehensively. Otherwise, hydroelectric licenses low in a watershed could claim that passage is not feasible because there is no habitat available upstream of their project, and licensees high in a watershed could claim that passage is not required because fish are not currently blocked by their facilities. This logic would negate the authority of the regulatory agencies under section 18 of the FPA.

The Applicant is responsible for current and reasonably forseeable future impacts associated with its Project. Fish passage through Oroville and the intervening dams is reasonably forseeable at sometime in the next 30-50 years, therefore the project certainly has the potential to impact anadromous fisheries resources. In order to meet NOAA Fisheries requirements, a thorough evaluation must be conducted in good faith, and in full cooperation with other FERC processes and agencies operating in the Feather River basin. NOAA Fisheries finds no reason not to examine the feasibility of fish passage, and failure to do so will result in a deficient license (e.g. 18 CFR 16.8).

NOAA FISHERIES RESOURCE MANAGEMENT GOALS AND OBJECTIVES

Resource Goals

1. Protect, conserve, enhance, and recover native anadromous salmonids and their habitats by providing access to historic habitats and by restoring fully functioning habitat conditions.

2. Identify and implement measures to protect, mitigate or minimize direct, indirect, and cumulative impacts to, and enhance native anadromous salmonid resources, including related spawning, rearing, and migration habitats and adjoining riparian habitats.

Resource Objectives

If passage for anadromous fish is made available into the upper Feather River, some or all of the following objectives may be promoted to facilitate the protection, mitigation, or enhancement of anadromous fish species, and their associated terrestrial ecosystems. Other objectives may be promoted as new information and legislation becomes available.

1*. Flows -* Implement scheduled flows in the Feather River and regulated tributaries to the benefit of native anadromous salmonids and their habitats. This includes providing a range or schedule of flows necessary to: a) optimize suitable habitat; b) stabilize flows during spawning and incubation of ingravel forms; c) facilitate the efficient migration of spawning adults, safe and timely emigration of smolts, and movement of rearing juveniles between feeding and sheltering areas; d) ensure redd placement in viable areas; and e) preserve channel forming processes, riparian habitat protection, and maintenance movement of forage communities. This also includes impacts of flood control, irrigation, or other project structures or operations that act to displace individuals or their forage or destabilizes, scours, or degrades physical, chemical, or biological quality of habitat.

2. *Water Quality -* Modify project structures or operations necessary to mitigate direct, indirect, or cumulative water temperature and quality impacts associated with project structures and operations or enhance water temperature and quality conditions in salmonid habitat.

3. ***Water Availability -*** Coordinate operations with other projects, programs or initiatives, and/or use water transfers, water exchanges, water purchases or other forms of agreements to maximize potential benefits to anadromous salmonids that are affected by limited water supplies.

4. ***Fish Passage -*** Provide passage for anadromous fish to the Feather River above Oroville Dam, as necessary to restore access to historic spawning, rearing and migration habitats within or near the project. Access into the Project may include passive or active structures or devices which provide upstream and/or downstream passage. Passage within or near of the Project boundary may include modifications to project facilities and operations necessary to ensure the safe, timely, and efficient passage of upstream migrating adults, downstream passage of emigrating juveniles, and passage necessary for juveniles to access habitat necessary for the seasonal movement of rearing juveniles to feeding and shelter habitats.

5. ***Channel Maintenance -*** Implement flow regimes and non-flow related measures necessary to mitigate and minimize direct, indirect, and cumulative impacts of project facilities and operations on sediment movement and deposition, river geometry, and channel characteristics. This includes impacts on stream competence, capacity, flood plain conductivity, bank stability and extent, duration, and repetition of high flow events. In addition, this includes impacts to habitat diversity and complexity such as pool riffle sequencing and instream cover.

6. ***Hatchery Operations -*** Minimize and mitigate the impact of hatchery facilities and/or operations (e.g. fish stocking) on native, anadromous salmonids. This includes the direct, indirect, and cumulative impacts of hatchery product on anadromous salmonids and the direct, indirect and cumulative impacts of hatchery facilities and operations on salmonids and their habitats.

7. ***Predation -*** Minimize and mitigate the impact of Project structures or operations that either have in the past or continue to introduce predators, create suitable habitat for predators, harbor predators, or are conducive to the predation of native anadromous salmonids.

8. ***Riparian Habitat -*** Protect, mitigate or minimize direct, indirect, and cumulative impacts to, and enhance riparian habitat and habitat functions necessary to mitigate and minimize direct, indirect and cumulative impacts of project facilities and operations.

9. ***Flow Ramping -*** Modify project structures or operations necessary to minimize impacts of flow fluctuations associated with increases of decreases in project discharges. Flow modifications may be necessary to provide passage at artificial or natural barriers (e.g. Seneca Falls, a partial barrier for salmonids at low flow).

10. ***Coordination -*** In developing alternatives for relicensing, include a full range of alternatives for modifying project and non-project structures and operations to the benefit of anadromous salmonids and their habitats, while minimizing conflicts with operational requirements and other beneficial uses. This includes developing alternatives for greater coordination with other stakeholders and water development projects to ensure that, at a minimum, project structures and operations are consistent with on-going and future fishery restoration efforts and potentially enhance these efforts.

LITERATURE CITED AND ADDITIONAL SUPPORTING REFERENCES

Alexander, G. R, and E. A. Hansen. 1986. Sand bed load in a brook trout stream. North American Journal of Fisheries Management 6:9-23.

Allan, D.J. 1995. Stream Ecology Structure and Function of Running Waters, Chapman and Hall, London: 388 pp.

Angermeier, P.L. and I. J. Schlosser. 1989. Species-area relationships for stream fishes. Ecology 70:1450-1462.

Baker, P., and F. Reynolds. 1986. Life history, habitat requirements, and status of coho salmon in California. Report to the California Fish and Game Commission.

Barnhart, R.A. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest), steelhead. United States Fish and Wildlife Service Biological Report 82(11.60).

Bartholow, J.M. 1995. Review and analysis of Klamath River basin water temperatures as a factor in the decline of anadromous fish with recommendations for mitigation. River Systems Management Section, Midcontinent Ecological Science Center, U.S. National Biological Service, Fort Collins, Colorado. Final Draft.

Bell, M.C. 1973. Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program, U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Bell, M. C. 1991. Fisheries handbook of engineering requirements and biological criteria. Fish Passage Development and Evaluation Program, U.S. Army Corps of Engineers, North Pacific Division, Portland, Oregon.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams. Pages 83-138 *in* W.R. Meehan, editor. Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland. 751 pages.

Boles, G. 1988. Water temperature effects on Chinook salmon (*Oncorhynchus tshawytscha*) with emphasis on the Sacramento River: a literature review. Report to the California Department of Water Resources, Northern District. 43 pages.

Brett, J.R. 1952. Temperature tolerance of young Pacific salmon, genus *Oncorhynchus*. Journal of the Fisheries Research Board of Canada 9:265-323.

Briggs, J.C. 1953. The behavior and reproduction of salmonid fishes in a small coastal stream. Calif. Dep. Fish Game Fish. Bull. 94:62 p.

Brown, L.R, and P.B. Moyle. 1991. Status of coho salmon in California. Report to the Natl. Mar. Fish. Serv., 114 pages. (Available from Natl. Mar. Fish. Serv., Environmental and Technical Services Division, 525 N.E. Oregon Street, Portland, OR 97232).

Brown, L.R., P.B. Moyle, and R.M. Yoshiyama. 1994. Historical decline and current status of coho salmon in California. North American Journal of Fisheries Management 14:237-261.

Busby, P.J., T.C. Wainwright, G.J. Bryant., L. Lierheimer, R.S. Waples, F.W. Waknitz and I.V. Lagomarsino. 1996. Status review of west coast steelhead from Washington, Idaho, Oregon and California. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NOAA Fisheries-NWFSC-27. 261 pages.

Bustard, D.R., and D.W. Narver. 1975. Aspects of the winter ecology of juvenile coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). J. Fish. Res. Board Can. 32:667-680.

Cada, G.F., M.D. Deacon, S.V. Mitz, and M.S. Bevelhimer. 1994. Review of information pertaining to the effect of water velocity on the survival of juvenile salmon and steelhead in the Columbia River Basin. Prepared by Oak Ridge National Laboratory for the Northwest Power Planning Council, Portland, Oregon. February. 71 p.

California Department of Fish and Game (CDFG). 1965. California Fish and Wildlife Plan, Volume I: Summary; Vol. II: Fish and Wildlife Plans; Vol. III: Supporting Data. California Department of Fish and Game, Sacramento, California.

California Department of Fish and Game (CDFG). 1994a. Petition to the California Board of Forestry to list coho salmon (*Oncorhynchus kisutch*) as a sensitive species. Calif. Dep. Fish Game Rep. 35 pages plus appendices. (Available from Board of Forestry, 1416 Ninth, Sacramento, CA 95814).

California Department of Fish and Game (CDFG). 1994b. Juvenile anadromous salmonid outmigration studies, Bogus Creek and Shasta River (Klamath River Basin) 1986 through 1990. California Department of Fish and Game. Klamath Trinity Program, Inland Fisheries Division.

California Department of Fish and Game (CDFG). 1997. Eel River Salmon and Steelhead Restoration Action Plan, Final Review Draft, January 28, 1997. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California.

California Department of Fish and Game (CDFG). 1998. Report to the Fish and Game Commission. A status review of the Spring-Run Chinook salmon (Oncorhynchus tshawytscha) in the Sacramento River Drainage. Candidate species status report 98-01.

California Department of Fish and Game (CDFG). 2000a. Annual Report: Trinity River Basin salmon and steelhead monitoring project 1999-2000 season. California Department of Fish and Game. Northern California-Northcoast Region.

California Department of Fish and Game (CDFG). 2000b. Documentation of the Klamath River Fish Kill, June 2000. Attachment to an October 25, 2000, Memorandum from G. Stacey, CDFG, to D. Koch, CDFG. 17 p. plus appendix.

California Department of Fish and Game (CDFG). Unpublished data. Adult coho salmon counts from weirs in Shasta and Scott rivers and Bogus Creek. Source: Mark Hampton, California Department of Fish and Game, Yreka, CA.

Campbell, S. G. 1995. Klamath River Basin flow-related scoping study -phase I, water quality. In: Compilation of phase I reports for the Klamath River Basin, May 1995. Prepared for the Technical Work Group of the Klamath River Basin Fisheries Task Force by River Systems

Management Section, National Biological Service, Midcontinent Ecological Service Center, Fort Collins, CO

Castelle, A. J., A. W. Johnson, and C. Conolly. 1994. Wetland and stream buffer size requirements-a review. Journal of Environmental Quality 23:878-882.

Cederholm, C. J., and D. J. Martin. 1983. Habitat requirements and life history of wild salmon and trout. pp 88 - 102 in Proceedings of the Salmon and Trout Conference, March 11-12, Seattle University, Washington.

Chamberlin, T. W., R. D. Harr, and F. H. Everest. 1991. Timber harvesting, silviculture, and watershed processes. Pages 181-205 *in* W.R. Meehan (ed.), Influences of Forest and Rangeland Management. American Fisheries Society Special Publication 19.

Chapman, D.W. 1962. Aggressive behavior in juvenile coho salmon as a cause of emigration. J. Fish. Res. Bd. Can. 19:1047-1080.

Chapman, D.W. 1966. Food and space as regulators of salmonid populations in streams. Am. Nat. 100:345-357.

Chase, S., R. Benkert, D. Manning, S. White, and S. Brady. 2000. Results of the Sonoma County Water Agencys Mirabel rubber dam/Wohler pool reconnaissance fish sampling program 1999; Preliminary/Subject to revision. Sonoma County Water Agency. Santa Rosa, CA 53+pp.

Chapman, D.W., and T.C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. Pages 153-176. *in*: T.G. Northcote, editor. Symposium on Salmon and Trout in Streams. H.R. Macmillan Lectures in Fisheries. Institute of Fisheries, University of British Columbia, Vancouver, British Columbia.

Clancey, C.G. 1980. Vital statistics and instream flow requirements of fish in the Montco Mine area of the Tongue River, Montana. Montana Department of Fish, Wildlife and Parks, Helena: 55 pp.

Clark, G.H. 1929. Sacramento-San Joaquin salmon (Oncorhynchus tshawytscha) fishery of California. Calif. Fish Game Bull.17:73.

Close, D.W., M.S. Fitzpatrick and H.W. Li. The Ecological and Cultural Importance of a Species at Risk of Extinction, Pacific Lamprey. Fisheries. 27(7):19-25.

Coble, D.W. 1961. Influence of water exchange and dissolved oxygen in redds on survival of steelhead trout embryos. Transactions of the American Fisheries Society 90(4):469-474.

Cushman. R.M. 1985. Review of ecological effects of rapidly varying flows downstream from hydroelectric facilities. N. Am. J. Fish. Mgmt. 5:330-339.

Davis, G.E., J. Foster, C.E. Warren, and P. Doudoroff. 1963. The influence of oxygen concentration on the swimming performance of juvenile Pacific salmon at various temperatures. Transactions of the American Fisheries Society. 92(2):111-124.

Deas, Michael L. and G.T. Orlob. 1999. Klamath River Modeling Project. Center for Environmental and Water Resources Engineering, Department of Civil and Environmental Engineering, Water Resources Modeling Group. University of California, Davis. Sponsored by the United States Fish and Wildlife Service, Klamath Basin Fisheries Task Force. December.

Dettman, D. H. 1978. Factors influencing the distribution, abundance and microhabitat segregation of rainbow trout and Sacramento squawfish in Deer Creek, California. M.S. Thesis in Ecology, University of California at Davis.

Dickhoff, W.W., L.C. Folman, J.L. Mighell and C.V.W. Mahnken 1982. Plasma thyroid hormones during smoltification of yearling and underyearling coho salmon and yearling Chinook salmon. Aquaculture 28 (1982): 39-48.

Eames, M., T. Quinn, K. Reidinger, and D. Haring. 1981. Northern Puget Sound 1976 adult coho and chum tagging studies. Washington Department of Fisheries Technical Report 64:1-136.

Edmundson, E., F. E. Everest, and D. W. Chapman. 1968. Permanence of station in juvenile Chinook salmon and steelhead trout. Journal of Fisheries Resource Board of Canada, 25(7): 1453-1464, 1968.

Edwards, E.A., G. Gebhart and O. E. Maughan 1983. Habitat Suitability information: smallmouth bass, FWS/OBS-82/10.36.

Everest, F.H. 1973. Ecology and management of summer steelhead in the Rogue River. Oregon State Game Commission., Fishery Research Report 7, Corvallis, Oregon.

Everest, F.H., and D.W. Chapman. 1972. Habitat selection and spatial interaction by juvenile Chinook salmon and steelhead trout. Journal of the Fisheries Research Board of Canada 29:91-100.

Fausch, K.D., and R.J. White. 1986. Competition among juveniles of coho salmon, brook trout, and brown trout in a laboratory stream, and implications for Great Lakes tributaries. Trans. Am. Fish. Soc. 115:363-381.

Fausch, K.D., and T.G. Northcote. 1992. Large woody debris and salmonid habitat in a small coastal British Columbia stream. Can. J. Fish. Aquat. Sci. 49:682-693.

Fausch, K.D., and M.K. Young. 1995. Evolutionarily significant units and movement of resident stream fishes: a cautionary tale. Am. Fish. Soc. Symp. 17:360-370.

Folmar, L.C., W.W. Dickhoff, C.V.W. Mahnken, and F.W. Waknitz. 1982. Stunting and parr-revision during smoltification of coho salmon. Aquaculture 28 (1982): 91-104.

Furniss, M. J., T. D. Roelofs, and C. S. Yee. 1991. Road construction and maintenance. Pages 297-323 *in* W.R. Meehan (ed.), Influences of

Forest and Rangeland Management. American Fisheries Society Special Publication 19.

Gorman, O.T. and J.R. Karr. 1978. Habitat structure and stream fish communities. Ecology 59:507-515.

Gowan, C., Young, M. K., Fausch, K. D., and S. C. Riley. 1994. Restricted movement in resident stream salmonids: A paradigm lost? Canadian Journal of Fisheries and Aquatic Sciences 50: 2626-2637.

Gregory, S.V. and P.A. Bisson. 1997. Degradation and loss of anadromous salmonid habitat in the Pacific Northwest. Pages 277-314 *in* D.J. Stroud, P.A. Bisson, and R.J. Naiman, eds., Pacific Salmon and Their Ecosystems – Status and Future Options.

Gregory, S. V., F. J. Swanson, W. A. McKee, and K. W. Cummins. 1991. An ecosystem perspective of riparian zones. BioScience 41:540-551.

Groot, C., and L. Margolis. 1991. Pacific salmon life histories. UBC Press. Vancouver, BC. 564 pp.

Hall, J. D., and R. L. Lantz. 1969. Effects of logging on the habitat of coho salmon and cutthroat trout in coastal streams. Pages 355 to 376 in T. G. Northcote (ed.) Symposium on salmon and trout in streams, Institute of Fisheries, University of British Columbia, Vancouver.
Harmon, R., J.S. Foott, K. Nichols, J. Faukner, and B. McCasland.
2001. Physiological responses of juvenile Chinook salmon held in the Lower Klamath River and thermal refugia (June - August 2000). U.S. Fish and Wildlife Service, California-Nevada Fish Health Center, Anderson,CA. February. 26 pages.

Hart, J.L. 1973. Pacific Fishes of Canada. Bulletin 180, Fisheries Research Board of Canada, Ottawa, 740 pages.

Hassler, T.J. 1987. Species Profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest) - coho salmon. United States Fish and Wildlife Service Biological Report 82:1-19.

Hausle, D.A., and D.W. Coble. 1976. Influence of sand in redds on survival and emergence of brook trout. Trans. Am. Fish. Soc. 105: 57-63.

Hartman, G.F. 1965. The role of behaviour in the ecology and interaction of underyearling coho salmon (*Oncorhynchus kisutch*) and steelhead trout (*Salmo gairdneri*). J. Fish. Res. Board Can. 22:1035-1081.

Hartman, G.F., and J.C. Scrivener. 1990. Impacts of forest practices on a coastal stream ecosystem, Carnation Creek, British Columbia. Canadian Bulletin of Fisheries and Aquatic Sciences 223.

Hassler, T.J. 1987. Species profiles: Life histories and environmental requirements of coastal fishes and invertebrates (Pacific Southwest)--coho salmon. U.S. Fish and Wildl. Serv. Biol. Rep. 82(11.70). 19 pages.

Healey, M.C. 1991. Life history of Chinook salmon (*Oncorhynchus tshawytscha*). Pages 312-393 *in* C. Groot and L. Margolis, editors. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver. 564 pages.

Hearn, W.E. 1987. Interspecific competition and habitat segregation among stream-dwelling trout and salmon: a review. Fisheries 12: 24-31.

Hecht, B., and G. R. Kamman. 1996. Initial Assessment of Pre- and Post-Klamath Project Hydrology on the Klamath River and Impacts of the Project on Instrean Flows and Fishery Habitat. Balance Hydrologics., Inc. March.

Heifetz, J., M.L. Murphy, and K.V. Koski. 1986. Effects of logging on winter habitat of juvenile salmonids in Alaskan streams. N. Am. J. Fish. Manage. 6:52-58.

Henriksen, J. 1995. Availability of life history information for anadromousfish in the Klamath and Trinity Rivers. In: Compilation of phase I reports for the Klamath River Basin, May 1995. Prepared for the Technical Work Group of the Klamath River Basin Fisheries Task Force by River Systems Management Section, National Biological Service, Midcontinent Ecological Service Center, Fort Collins, CO.

Hicks, B. J., Hall, J. D., Bisson, P. A., and J. R. Sedell. 1991. Responses of salmonids to habitat changes. Pages 483-518 *in* W.R. Meehan (ed.), Influences of Forest and Rangeland Management. American Fisheries Society Special Publication 19.

Higgins, P., S. Dobush, and D. Fuller. 1992. Factors in northern California threatening stocks with extinction. Unpubl. manuscr., Humboldt Chapter Am. Fish. Soc., 24 p. (Available from Humboldt Chapter of the American Fisheries Society, P.O. Box 210, Arcata, CA 95521.)

Hoar, W.S. 1951. The behaviour of chum, pink, and coho salmon in relation to seaward migration. J. Fish. Res. Board Can. 8:241-263.

_____. 1958. The evolution of migratory behaviour among juvenile salmon of the genus *Oncorhynchus*. J. Fish. Res. Board Can. 15391-428.

Horan, D.L. , J.L. Kershner, C.P. Hawkins and T.A. Crowl. 2000. Effects of habitat area and complexity on Colorado River cutthroat trout density in Uinta mountain streams. Transactions of the American Fisheries Society 129:1250-1263.

Hydrosphere Data Products, Inc. 1993. Hydrodata Regional CD-ROMs: U.S. Geological Survey daily values, Vols. West 1, West 2. (Available from Hydrosphere Data products, Inc., 1002 Walnut, Suite 200, Boulder, CO 80302)

IEP SPWT Interagency Ecological Program Steelhead Project Work Team. 1999. Monitoring, Assessment, and Research on Central Valley Steelhead: Status of Knowledge, Review of Existing Programs, and Assessment of Needs. Tech. Append. VII-A-11 of the CMARP Recommendations for the Implementation and Continued Refinement of a Comprehensive

Monitoring, Assessment, and Research Program, March 10, 1999 Report.

Institute For Natural Systems Engineering (INSE). 1999. Evaluation of interim instream flow needs in the Klamath River: Phase I final report. Prepared for the Department of Interior. 53 p. plus appendixes.

Johnson, S.L. 1988. The effects of the 1983 El Niño on Oregon's coho (*Oncorhynchus kisutch*) and Chinook (*O. tshawytscha*) salmon. Fisheries Research 6:105-123.

Karr, J. R., and I. J. Schlosser. 1978. Water resources and the land-water interface. Science 201:229-234.

Klamath River Basin Fisheries Task Force (KRBFTF). 1991. Long Range Plan for the Klamath River Basin Conservation Area Fishery Restoration Program. Klamath River Basin Fisheries Task Force. January.

Kostow, K. 1995. Biennial Report on the Status of Wild Fish in Oregon. Oregon Department of Fish and Wildlife, Portland, Oregon. 217 pages plus appendices.

Larkin, P.A. 1977. Pacific Salmon. In J.A. Gulland (ed.) Fish population dynamics. J. Wiley and Sons, New York, NY.

Lee, R.M., and J.N.Rinne. 1980. Critical thermal maxima of five trout species in the southwestern United States. Trans. Am. Fish. Soc. 109:632-635.

Leider, S., M.W., and J.J. Loch. 1986. Movement and survival of presmolt steelhead in a tributary and the mainstem of a Washington River. N. Am. J. Fish. Mgmt. 6:526-531.

Leidy, R.A., and G.R. Leidy. 1984. Life Stage periodicities of anadromous salmonids in the Klamath River Basin, northwestern California. United States Fish and Wildlife Service, Sacramento, California. 38 pages.

Li., H.W., K. Currens, D. Bottom S Clarke, J. Dambacher, C. Frissel, P. Harris, R. M. Hughes, D. McCollough, A. McGie, K. Moore R. Nawa and S. Thiele.1995. Safe havens: refuges and evolutionarily significant units. In Nielsen (ed.) Evolution and the Aquatic Ecosystem, American Fisheries Society Symposium 17, Bethesda, Maryland: 371-380.

Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabitating underyearlings of Chinook (*Oncorhynchus tshawytscha*) and coho (*Oncorhynchus kisutch*) salmon in the Big Qualicum River, British Columbia. J. Fish. Res. Board Can. 27:1215-1224.

Lowrance, R., and twelve co-authors. 1995. Water quality functions of riparian forest buffer systems in the Chesapeake Bay Watershed. U. S. Environmental Protection Agency, EPA 903-R-95-004.

McCormick, J., J.Howard, and J. Wegner. 1981. Responses of largemouth bass from different latitudes to elevated water temperatures. Trans. Am. Fish. Soc. 110: 417-429.

McCormick, S.D., and R.L. Saunders. 1987. Preparatory physiological adaptations for marine life of salmonids: Osmoregulation, growth, and metabolism. Amer. Fish. Soc. Symposium 1:211-229.

McEwan, D., and T.A. Jackson. 1996. Steelhead Restoration and Management Plan for California. California Department of Fish and Game, Sacramento, California.

McEwan, D.R. 2001. Central Valley Steelhead. Contributions to the biology of Central Valley salmonids. R. Brown ed. Calif.
Dept. of Fish and Game Fish Bull. No 179.

McMahon, T.E. 1983. Habitat suitability index models: coho salmon. United States Fish and Wildlife Service, FWS/OBS-82/10.49, 29 pages.

McMahon, T.E., and G.F. Hartman. 1989. Influence of cover complexity and current velocity on winter habitat use by juvenile coho salmon. Can. J. Fish. Aquat. Sci. 46:1551-1557.

McRae, G., and C.J. Edwards. 1994. Thermal characteristics of Wisconsin headwater streams occupied by beaver: implications for brook trout habitat. Trans. Am. Fish. Soc. 123:641-656.

Meehan, W. R., editor. 1991. Influences of forest and rangeland management on salmonid fishes and their habitats. American Fisheries Society Special Publication 19.

Meehan, W.R., and T.C. Bjornn. 1991. Salmonid distribution and life histories. Pages 47-82 *in* Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats. W.R. Meehan, editor. American Fisheries Society Special Publication 19. American Fisheries Society. Bethesda, Maryland.

Moyle, P.B. 1976. Inland Fishes of California. University of California Press. Berkeley, California. 405 pages.

Moyle, P.B. 2002. Inland Fishes of California. University of California Press. Berkeley, California. 502 pages.

Murphy, M.L. 1995. Forestry impacts on freshwater habitat of anadromous salmonids in the Pacific northwest and Alaska - Requirements for protection and restoration. NOAA Coastal Ocean Program Decision Analysis Series No. 7. NOAA Coastal Ocean Office, Silver Spring, MD. 156 p.

Myers, J.M., R.G. Kope, G.J. Bryant, D. Teel, L.J. Lierheimer, T.C. Wainwright, W.S. Grand, F.W. Waknitz, K. Neely, S.T. Lindley, and R.S. Waples. 1998. Status review of Chinook salmon from Washington, Idaho, Oregon, and California. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NOAA Fisheries-NWFSC-35. 443 pages.

National Marine Fisheries Service. 1996. Endangered and threatened species; threatened status for Central California Coast coho salmon Evolutionarily Significant Unit (ESU). Federal Register [Docket 950407093-6298-03, October 31, 1996]61(212): 56138-56149.

National Marine Fisheries Service. 1996a. Factors for decline: A supplement to the Notice of Determination for West Coast Steelhead under the Endangered Species Act. August 1996.

National Marine Fisheries Service. 1999. Biological opinion on operation of the Klamath Project through March 2000. NOAA Fisheries Southwest Region, 501 West Ocean Blvd., Suite 4200, Long Beach, California 90802. July 12.

National Research Council (NRC). 1996. Upstream: Salmon and society in the Pacific Northwest. National Academy Press. Washington, DC.

Nehlsen, W., J.E. Williams, and J.A. Lichatowich. 1991. Pacific salmon at the crossroads: Stocks at risk from California, Oregon, Idaho, and Washington. Fisheries 16(2):4-21.

Nickelson, T.E., J.W. Nicholas, A.M. McGie, R.B. Lindsay, D.L. Bottom, R.J. Kaiser, and S.E. Jacobs. 1992. Status of anadromous salmonids in Oregon coastal basins. Unpublished manuscript. Oregon Dept. Fish Wildl., Research and Development Section, Corvallis, and Ocean Salmon Management, Newport. 83 pages.

Nielsen, J.L. 1992. Microhabitat-specific foraging behavior, diet, and growth of juvenile coho salmon. Transactions of the American Fisheries Society 121:617-634.

Nielsen, J. L., T. E. Lisle, and V. Ozaki. 1994. Thermally stratified pools and their use by steelhead in northern California streams. Transactions of the American Fisheries Society 123:613-626.

North Coast Regional Water Quality Control Board. 1998. Transmittal letter for Clean Water Act Section 303(d) List of Water Quality Limited Waterbodies for California's North Coast Region. January 14.

Odum, E.P. 1971. Fundamentals of ecology, 3rd Ed. Saunders College Publishing. Philadelphia, PA.

Otto, R.G., and J.E. McInerney. 1970. Development of salinity preference in pre-smolt coho salmon, *Oncorhynchus kisutch*. J. Fish. Res. Board Can. 27:793-800.

Pacific Fishery Management Council (PFMC). 1997. Preseason Report III Analysis of Council Adopted Management Measures for 1997 Ocean Salmon Fisheries. May 1997. (Available from PFMC, 2130 SW Fifth Ave. Ste. 224, Portland, OR 97201)

PFMC. 1998. Preseason Report III Analysis of Council Adopted Management Measures for 1998 Ocean Salmon Fisheries. May 1998.

PFMC. 1999. Preseason Report III Analysis of Council Adopted Management Measures for 1999 Ocean Salmon Fisheries. May 1999.

Page, L.M., and B.M. Burr. 1991. A Field Guide to Freshwater Fishes of North America North of Mexico. Houghton Mifflin Company, New York, New York. 432 pages.

Palmisano. J, et al., 1993. The impact of environmental and management factors on

Washington's wild anadromous salmon and trout, Washington Forest Protection Association and the State of Washington Department of Natural Resources.

Pearsons, T.N., H.W. Li, and G.A. Lamberti. 1992. Influence of habitat complexity on resistance to flooding and resilience of stream fish assemblages. Transactions of the American Fisheries Society 121:427-436.

Phillips, R.W. and H.J. Campbell. 1961. The embryonic survival of coho salmon and steelhead trout as influenced by some environmental conditions in gravel beds. Annual Report of the Pacific Marine Fisheries Commission 14:60-73.

Platts, W. S. 1991. Livestock grazing. Pages 389 to 423 in W. R. Meehan (ed.) Influences of Forest and Rangeland Management on Salmonid Fishes and their Habitats. American Fisheries Society Special Publication 19.

Reclamation (United States Bureau of Reclamation). 1998. Biological Assessment on the Klamath Project 1998 operations plan. U.S. Bureau of Reclamation, Mid-Pacific Region, Klamath Area Office. Klamath Falls, Oregon. May. 76 p.

Reclamation. 1999a. Draft Klamath Project 1999 annual operations plan environmental assessment. U.S. Department of the Interior.

Reclamation. 1999b. Letter from K. Wirkus, Reclamation, to D. Reck, fishery biologist, NOAA Fisheries. April 26.

Reclamation. 2000. Letter from K. Wirkus, Reclamation, to R. McInnis, Acting Regional Administrator, NOAA Fisheries. April 26.

Reclamation. 2001. Biological Assessment of the Klamath Project's continuing operations on Southern Oregon/Northern California ESU coho salmon and critical habitat for Southern Oregon/Northern California ESU coho salmon. Mid-Pacific Region, Klamath Area Office. 54 p. Enclosure to a January 22, 2001, letter from K. Wirkus, Reclamation, to R. Lent, NOAA Fisheries.

Reiser, D.W., T.C. Bjornn. 1979. Habitat requirements of anadromous salmonids. Influence of Forest and Rangeland Management on Anadromous Fish Habitat in the Western United States and Canada. W.R. Meehan, editor. U.S. Department of Agriculture Forest Service General Technical Report PNW-96.

Reiser, D.W., and R.G.White. 1988. Effects of two sediment size-classes on survival of steelhead and Chinook salmon eggs. N. Am. J. Fish. Mgmt. 8:432-437.

Richter, B.D., J.V. Baumgartner, J. Powell, and D.P. Braun. 1996. A method for assessing hydrologic alteration within ecosystems. Conservation Biology 10(4):1163-74.

Salo, E., and W.H. Bayliff. 1958. Artificial and natural production of silver salmon, *Oncorhynchus kisutch*, at Minter Creek, Washington. Washington Department of Fisheries Research Bulletin 4, 76 pages, Washington Department of Fish and Wildlife, Olympia, Washington.

Sandercock, F.K. 1991. Life history of coho salmon (*Oncorhynchus kisutch*). Pages 395-445 *in* C. Groot and L. Margolis, editors. Pacific Salmon Life Histories. University of British Columbia Press, Vancouver, British Columbia, 564 pages.

Scott, W.B., and E.J. Crossman. 1973. Freshwater Fishes of Canada. Bulletin 184, Fisheries Research Board of Canada, Ottawa, 966 pages.

SEC. 1996. A history of the salmonid decline in the Russian River. Prepared by Steiner Environmental Consulting for Sonoma County Water Agency and California State Coastal Conservancy. Potter Valley, CA.

Shapovalov, L. and A.C. Taft. 1954. The life histories of the steelhead rainbow trout (*Salmo gairdneri gairdneri)* and silver salmon (*Oncorhynchus kisutch*) with special reference to Waddell Creek, California, and recommendations regarding their management. California Department of Fish and Game, Fish Bulletin 98:1-375.

Sletteland, T.B. 1995. Letter to Michael J. Ryan (Reclamation), and enclosure titled "Events Leading to the Construction of Iron Gate Dam and the Basis for Minimum Flow Releases to the Klamath River."

Smith, A.K. 1973. Development and application of spawning velocity and depth criteria for Oregon salmonids. Transactions of the American Fisheries Society 10(2):312-316.

Smith, O.R. 1939. Placer mining silt and its relation to salmon and trout on the Pacific Coast. Trans. Am. Fish. Soc. 69:135-139.

Spence, B.C., G.A. Lomnicky, R.M. Hughes, and R.P. Novitzki. 1996. An Ecosystem Approach to Salmonid Conservation. Management Technology. December. 356 p.

Stein, R.A., P.E. Reimers, and J.D. Hall. 1972. Social interaction between juvenile coho (*Oncorhynchus kisutch*) and fall Chinook salmon (*O. tshawytscha*) in Sixes River, Oregon. Journal of the Fisheries Research Board of Canada 29:1737-1748.

Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982a. Habitat suitability index models: green sunfish. FWS/OBS-82/10.15: 28 pp.

Stuber, R.J., G. Gebhart, and O.E. Maughan. 1982b. Habitat suitability index models: largemouth bass. FWS/OBS-82/10.16: 32 pp.

Sullivan, K., T. E. Lisle, C. A. Dolloff, G. E. Grant, and L. M. Reid. 1987. Stream channels: the link between forests and fishes. Pages 39-97 *in* Salo and Cundy (1987).

Tennant, D.L. 1976. Instream flow regimes for fish, wildlife, recreation and related environmental resources. Fisheries 1(4): 6-10.

Thomas, J.W. et al. 1993. Viability assessments and management considerations for species associated with late-successional and old-growth forests of the Pacific northwest: The report of the Scientific Analysis Team. USDA, Forest Service Research. March. 530 p.

Thompson, K. 1972. Determining stream flows for fish life. Proceedings, Instream Flow Requirement Workshop. Pacific Northwest River Basin Commission, Vancouver, Washington.

Titus, R.G., D.C. Erman, W.M. Snider. 1999. History and status of steelhead in California coastal drainages south of San Francisco Bay.

California Dept. Fish and Game. Draft manuscript. 261 pp.

Trihey and Associates. 1996. Instream Flow Requirements for Tribal Trust Species in the Klamath River. Prepared on behalf of the Yurok Tribe. March. 43 p.

Tschaplinski, P.J., and G. F. Hartman. 1983 winter distribution of juvenile coho salmon (*Oncorhynchus kisutch*) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. Can. J. Fish. Aquat. Sci. 40:452-461.

UDSA, Forest Service et al. 1993. Forest Ecosystem Management: An ecological, economic, and social assessment. Report of the Forest Ecosystem Management Assessment Team (FEMAT). July.

USDA, Forest Service and USDI, Bureau of Land Management. 1994. Record of decision for amendments to Forest Service and Bureau of Land Management planning documents within the range of the northern sported owl; standards and guidelines for management of habitat for late-successional and old-growth forest related species within the range of the northern spotted owl. April.

U.S. Environmental Protection Agency (USEPA). 1993. Letter to State Water Resources Control Board with Staff Report Supporting Final Action California 303(d) List. October 19.

USFWS. 1997a. Klamath River (Iron Gate Dam to Seiad Creek) life stage periodicities for Chinook, coho, and steelhead. Coastal California Fish and Wildlife Office. Arcata, California.

USFWS. 1997b. Letter and report to the California Regional Water Quality Control Board regarding dissolved oxygen levels in the Klamath River. September 23.

USFWS. 1998. Letter from Tom Shaw to Mike Rode, California Department of Fish and Game, regarding stranding of fish in isolated pools after drop in flow releases at Iron Gate Dam. May 7.

Vogel, D. A., and K. R. Marine. 1994. Preliminary assessment of increased Klamath River flows for salmon during the late summer and fall of 1994. A report prepared for the Klamath Water Users Association. Vogel Environmental Services. 36 pp.

Wales, J.H. 1944. The Klamath River at Different Stages of Flow. California Department of Fish and Game. Inland Fisheries Branch. Administrative Report 44-25, dated November 13, 1944. 13p.

Wang, L., J. Lyons, P. Kanehl, and R. Gratti. 1997. Influences of watershed land use on habitat quality and biotic integrity in Wisconsin streams. Fisheries 6:6-12.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Dep. Commer., NOAA Tech Memo. NOAA Fisheries-NWFSC-24, Northwest Fisheries Science Center, Seattle, Washington. 258 pages.

Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status Review of Coho Salmon from Washington, Oregon, and California. United States Department of Commerce, National Oceanic and Atmospheric Administration Technical Memorandum NOAA Fisheries-NWFSC-24, 258 pages.

Welsch, D. J. 1991. Riparian forest buffers: functions and design for protection and enhancement of water resources. USDA Forest Service, NA-PR-07-91, Radnor, Pennsylvania.

Wesche, T. A., C. M. Goertler, and C. B. Frye. 1987. Contributions of riparian vegetation to trout cover in small streams. North American Journal of Fisheries Management 7:151-153.

Wilcove, D.S., C.H. McLellan, and A.P. Dobson. 1986. Habitat fragmentation in the temperate zone. In M.E. Soule (ed.) Conservation Biology: the science and scarcity of diversity. Sinauer, Sunderland, MA.

Wilcox, B.A., and D.D. Murphy. 1985. Conservation strategy: the effects of fragmentation on extinction. Am. Naturalist. 125:879-887.

Winkle, P., W. Hubert, and F.Rahel. 1990. Relations between brook trout standing stocks and habitat features in beaver ponds in southeastern Wyoming. N. Am. J. Fish. Mgmt. 10: 72-79.

The Wilderness Society. 1993. The living landscape, Volume 2. Pacific salmon on Federal lands. The Wilderness Society, Bolle Center for Forest Ecosystem management, Seattle, WA. 87 pp + appendices.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher, and P.B. Moyle. 1996. Historical and present distribution of Chinook salmon in the Central Valley drainage of California. Sierra Nevada Ecosystem Project: Final report to Congress, vol.III. Centers for Water and Wildland Resources, Univ. Cal. Davis. pg. 309-361.

Yoshiyama, R.M., E.R. Gerstung, F.W. Fisher and P.B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. *in* Contributions to the Biology of Central Valley Salmonids. Fish Bulletin 179. R.L. Brown ed.